

Please type a plus sign (+) inside this box [+]

PTO/SB/05 (12/97)

Approved for use through 09/30/00. OMB 0651-0032

Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

UTILITY PATENT APPLICATION TRANSMITTAL
(Only for new non-provisional applications under 37 CFR 1.53(b))

Attorney Docket No. 20820.P092

Total Pages 2

First Named Inventor or Application Identifier Darrell Duffey

Express Mail Label No. EL143556822US

ADDRESS TO: **Assistant Commissioner for Patents**
Box Patent Application
Washington, D. C. 20231

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. X Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)
2. X Specification (Total Pages 40)
(preferred arrangement set forth below)
 - Descriptive Title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claims
 - Abstract of the Disclosure
3. X Drawings(s) (35 USC 113) (Total Sheets 7)
4. X Oath or Declaration (Total Pages 5)
 - a. Newly Executed (Original or Copy)
 - b. Copy from a Prior Application (37 CFR 1.63(d))
(for Continuation/Divisional with Box 17 completed) (**Note Box 5 below**)
 - i. DELETIONS OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. Microfiche Computer Program (Appendix)
7. Nucleotide and/or Amino Acid Sequence Submission

(if applicable, all necessary)

- a. ☐ Computer Readable Copy
b. ☐ Paper Copy (identical to computer copy)
c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. ☒ Assignment Papers (cover sheet & documents(s))
9. ☐ a. 37 CFR 3.73(b) Statement (where there is an assignee)
☐ b. Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ☐ a. Information Disclosure Statement (IDS)/PTO-1449
☐ b. Copies of IDS Citations
12. ☐ Preliminary Amendment
13. ☒ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
14. ☐ a. Small Entity Statement(s)
☐ b. Statement filed in prior application, Status still proper and desired
15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. Other: _____

17. If a **CONTINUING APPLICATION**, check appropriate box and supply the requisite information:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP)
of prior application No: _____

18. Correspondence Address

☐ Customer Number or Bar Code Label _____
(Insert Customer No. or Attach Bar Code Label here)
or

☒ Correspondence Address Below

NAME Thomas C. Webster, Reg. No. 46,154
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

ADDRESS 12400 Wilshire Boulevard
Seventh Floor

CITY Los Angeles STATE California ZIP CODE 90025-1026

Country U.S.A. TELEPHONE (408) 720-8598 FAX (408) 720-9397

20820.P092

Patent

UNITED STATES PATENT APPLICATION

for

A SYSTEM AND METHOD FOR PROVIDING
TRANSACTION CONTROL ON A DATA NETWORK

INVENTORS:

Darrell Duffy
Glen Riley

Prepared by:

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN, LLP
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES, CALIFORNIA 90025
(408) 720-8598

Attorney's Docket No. 20820.P092

"Express Mail" mailing label number EL143556822US

Date of Deposit August 11, 2000

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.

Cindy Murphy
(typed or printed name of person mailing paper or fee)

Cindy Murphy
(Signature of person mailing paper or fee)

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates generally to network configuration techniques. More particularly, the invention relates to an improved system and method for
5 selecting repeaters in a data network.

Description of the Related Art

A "repeater" is a communications device that amplifies or regenerates a data signal in order to extend the transmission distance between two or more nodes. Repeaters are available for both analog and digital signals and are used
10 extensively for long distance transmission.

The determination as to where repeaters should be configured/positioned within a network is typically based on the network topology. For example, the physical distance between nodes on the network may be used to determine whether a repeater is necessary. Factored into this calculation is the extent to
15 which data signals will degrade through the physical medium interconnecting nodes on the network. Different types of physical media (e.g., twisted pair, coaxial cable, wireless, . . . etc) have different signal-loss characteristics.

In some circumstances, however, network topology may be unknown at the time the network nodes are interconnected. For example, in circumstances
20 where existing power lines are used to support a communications network,

distances between network nodes may not be easily determined. As such, repeater positioning must be accomplished manually, through trial-and-error, by measuring signal strength at various points within the network and configuring repeaters as required.

- 5 Accordingly, what is needed is a more efficient system and method for selecting repeaters within a network. What is also needed is a system and method wherein nodes on a network which perform a particular function may configured as repeaters (i.e., in addition to performing that function).

10

SUMMARY OF THE INVENTION

A system is described comprising: a source node configured to transmit a data packet to a target node across a data network, the source node having a first retry timer set to a first retry time period after which the source node will
5 retransmit a data packet if it has not received an appropriate response to the data packet; and a first intermediate node electrically positioned between the source node and the target node, the first intermediate node having a second retry timer set to a second retry time period after which the first intermediate node will retransmit the data packet if it has not received an appropriate response to the
10 data packet, wherein the first retry time period is longer than the second retry time period.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention can be obtained from the following detailed description in conjunction with the following drawings, in which:

5 **FIG. 1** illustrates a network architecture for implementing various embodiments of the invention.

FIGS. 2a and **2b** illustrate one embodiment of a method for selecting repeaters on a network.

10 **FIG. 3** illustrates signal strength between a plurality of nodes and a master node.

FIG. 4 illustrates packet addressing according to one embodiment of the invention.

15 **FIG. 5a** illustrates communication between a proxy source, a proxy repeater, a proxy agent and a proxy target according to one embodiment of the invention.

FIG. 5b illustrates a transaction control between a proxy agent and a proxy target according to one embodiment of the invention.

PRIORITY

This application is a continuation-in-part of U.S. Serial No. 09/610,670, filed July 5, 2000, entitled "A System and Method for Selecting Repeaters."

DETAILED DESCRIPTION

5 In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of various embodiments of the invention. It will be apparent, however, to one skilled in the art that the embodiments of the invention may be practiced without some of these specific details. Moreover, in some instances, well-known
10 structures and devices are shown in block diagram form to avoid obscuring the underlying principles of the invention.

EMBODIMENTS OF THE INVENTION

15 **Figure 1** generally depicts a network over which a plurality of nodes 100, 101-103, 111-113, 121-125 and 131-134 communicate. In one embodiment, each of the nodes is comprised of a processor (e.g., a microcontroller or a micro-processor) and memory. In addition, each node may be configured to store, process and communicate (internally or with other nodes) code and data using machine-readable media such as magnetic disks, random access memory ("RAM"), read only memory ("ROM"), carrier wave signals, etc. Moreover,
20 while particular embodiments of the invention may be implemented in software,

alternative embodiments may implement the functions described herein using any combination of software, firmware and/or hardware.

In one particular embodiment, the nodes 100, 101-103, 111-113, 121-125 and 131-134 form a distributed control network such as the Lonworks® Network developed by Echelon® Corporation. In this embodiment, each of the nodes 100, 101-103, 111-113, 121-125 and 131-134 may be programmed to perform a specific task. For example, individual nodes may be configured as proximity sensors, switches, motion detectors, relays, motor drives, and/or other types of instruments (e.g., utility meters). The individual nodes of this embodiment may be programmed to work together as a whole to perform a complex control application such as running a manufacturing line or automating a building. It should be noted, however, that the underlying principles of the invention are not limited to any particular type of node or any particular network configuration or application.

Certain embodiments of the invention also employ a proxy communication protocol to extend the communication range of a network channel when it is impractical to use conventional routers to do so. These embodiments may be particularly suited for network media where “breaking” a physical channel into multiple channels via routers is not practical or possible (e.g., radio frequency (RF), power lines, . . . etc).

Repeater Selection

In one embodiment, certain nodes may be configured/programmed to function as repeaters in addition to the other functions performed by those nodes (some examples of which are set forth above). As illustrated in **Figure 1**, a

5 master node 100 may be configured to automatically select surrounding nodes 101-103, 111-113, 121-125 and 131-134 to perform repeater functions based on the detected signal strength at those nodes. In one embodiment, the master 100 is programmed with device addresses of each of the nodes, which the master 100 uses to query each of the nodes 101-103, 111-113, 121-125 and 131-134 for signal
10 strength data. After analyzing the signal strength data, the master 100 selects repeater candidates.

Figures 2a and 2b illustrate one embodiment of a method implemented by a master node to identify repeaters. At 210, the master initially attempts to communicate with all network nodes (e.g., by running through a list of node
15 addresses stored in memory).

In the illustrated embodiment, the master node 100 does not merely attempt to communicate but, rather, transmits "return signal strength" query to each of the surrounding nodes. Subsequently (at 215) the master node 100 receives a response from a subset of the nodes (i.e., from those nodes within the
20 transmission range of the master 100). Each response includes an indication of signal quality when the "return signal strength" query was received at each of

the nodes. In addition, in one particular embodiment, the master node 100 itself evaluates the signal quality of each node's response as it is received by the master 100. Accordingly, in this embodiment two signal strength values are used by the master node 100 to evaluate the overall signal strength between it
5 and each node on the network: an outgoing signal strength value (measured at the node); and an incoming signal strength value (measured at the master). The master may consider each value separately, may take the average of the two signal strength values or, alternatively, may weigh one value more heavily than the other. Various other techniques for evaluating the two signal strength values
10 may be employed while still complying with the underlying principles of the invention.

Each of the nodes 101-103, 111-113, 121-125 and 131-134 (including the master 100) may measure "signal strength" using a variety of techniques. For example, in one embodiment, the overall carrier strength (e.g., amplitude) of the
15 transmission is measured. Similarly, the signal-to-noise (S/N) ratio associated with the carrier signal may be calculated (i.e., by tracking the noise on the communication channel before and during the reception of the incoming signal). In addition, in one embodiment, the number of bit errors found in incoming data packet(s) may ^{be} calculated and used to provide an indication of the reliability of
20 the communication channel between the node and the master.

JK 8/3/00
DD 8/3/00

Certain techniques for measuring signal strength may be more appropriate than others depending on network conditions. For example, measuring overall carrier strength may be the most appropriate technique when the noise floor on the channel is below the receiver sensitivity. S/N Ratio may be more useful in cases where the noise on the channel is significant with respect to the signal level, and the number of errors corrected may be useful where other measures of signal strength are not available and/or there is an error correcting code available on the messages.

In one embodiment, the transmitter signal level may be purposely reduced to test the ability of a node to receive a signal. The transmitter signal level can be used as a measure of signal to noise ratio for the purposes of signal analysis. Use of this technique may require sending additional messages to probe for the level of reception.

Any of the foregoing signal strength measurement techniques, alone or in combination, may be employed by the nodes to evaluate "signal strength." Moreover, it should be noted that various other techniques may be employed while still complying with the underlying principles of the invention.

Once the master has collected signal strength values from a subset of all nodes, it performs signal strength analysis (at 220) to determine which nodes in the subset are "first tier" repeater candidates (i.e., those repeaters which will be

one transmission length or “hop” away from the master). The master’s goal, according to one embodiment, is not to select candidates with the highest measured signal strength but, rather, to select repeater candidates above some minimum (reliable) threshold value, T_{min} , and below some maximum threshold value T_{max} . In one embodiment, both the outgoing signal strength value (measured at the node) and the incoming signal strength value (measured at the master) must be above the minimum and/or below the maximum threshold value for the particular node to be selected as a repeater.

This concept is highlighted in **Figure 3**, which illustrates an exemplary signal strength relationship between the master 100 and the various nodes 101-103, 111-113, 121-125 and 131-134 shown in **Figure 1**. Nodes which are positioned further away from the master node 100 in **Figure 3** have a relatively lower signal strength value in relation to the master 100.

In the illustrated embodiment, nodes 101, 121, 122, and 131 all have relatively high signal strength values, above some maximum threshold 350 (as indicated). It would be inefficient for the master node 100 to select these nodes as repeater candidates, however, because they are not far enough away from the master node 100 to be useful as repeaters.

By contrast, nodes 103, 112-113, 124-125 and 132-134 are electronically distant from the master node 100 and have signal strength values below some

minimum threshold value 351. The master 100 will not initially select these nodes as repeaters because signal strength is so weak that they may prove to be unreliable. In fact, some or all may not even have received the master's 100 initial signal strength query.

5 Finally, nodes 102, 111, and 123 all have a signal strength value below the maximum threshold value 350 but above the minimum threshold value 351. They are far enough away from the master 100 to make them efficient selections for repeater candidates, while – at the same time – their signal strength is high enough to indicate that they will be reliable as first tier repeaters. Accordingly,
10 in the illustrated embodiment, the master node 100 initially selects nodes 102, 111, and 123 as first tier repeater candidates.

At 225, the master 100 transmits a “proxy return signal strength” command to each of the newly-selected first tier repeater candidates 102, 111, and 123. The “proxy return signal strength” command according to one
15 embodiment is similar to the “return signal strength” command except that it instructs a node (e.g., nodes 102, 111, and 123) to collect signal strength data from other nodes (i.e., those nodes that did not respond when the master 100 initially attempted to communicate with all nodes at 210), and to communicate the results back to the master 100. For the purposes of this example, it will be assumed that
20 none of the nodes below the minimum threshold value 351 have responded (i.e., nodes 103, 112-113, 124-125 and 132-134).

In response to the return signal strength command, node 102 queries node 103 for signal strength data. Subsequently, node 102 receives a response from node 103 which includes an indication of signal quality when the signal strength query was received at node 103. In addition, in one embodiment, node 102
5 evaluates the signal quality of node 103's response as it is received at node 102. Accordingly, the "proxy return signal strength" command, like the "return signal strength" command, collects an incoming signal strength value (measured at node 102) as well as an outgoing signal strength value (measured at node 103), and transmits the result back to the master 100.

10 Similarly, in the illustrated example, node 123 collects proxy signal strength data from node 124 and node 111 collects proxy signal strength data from nodes 112 and/or 113.

Once the proxy signal strength data is collected by the first tier repeater candidates, it is transmitted back to the master node 100 at 230. At 235, a method
15 variable 'N,' which represents the particular tier of nodes under analysis is set equal to two. It should be noted, however, that this initialization is only used for the purpose of describing the underlying process set forth in **Figures 2a and 2b**. No such variable initialization is required for complying with the underlying principles of the invention.

At 240, the master analyses the proxy signal strength data to determine which (if any) of the newly-identified nodes should be configured as a second tier repeater. Once again, this decision may be based on where the signal strength values fall within predetermined minimum and maximum signal strength thresholds (as with selection of the first tier of repeaters described above). Thus, node 112 in the illustrated example may be too close to repeater candidate 111 to be properly selected as a repeater (i.e., signal strength may be above the maximum value) but node 113 may be a sufficient distance away to make it an ideal repeater candidate (i.e., within both the minimum and maximum threshold requirements).

YR 8/3/00
DD 8/3/00

Once the master 100 has identified the second tier (or Nth tier) of repeater candidates, at 245 it instructs each of the nodes in the second tier to collect proxy return signal strength data for nodes that have yet to be identified. At 250, the master receives the latest set of proxy return signal strength data and (if any new nodes have responded, determined at 255) analyses the data to identify the next (e.g., the third) tier of repeater candidates. The master proceeds through successive tiers in this manner (i.e., tier $N=N+1$ with each iteration, as set forth in box 257) until no new nodes are identified using the proxy return signal strength commands. At this point, one embodiment of the system and method proceeds to the flowchart illustrated in **Figure 2b**.

YR 8/3/00
DD 8/3/00

At 265, the master determines whether all nodes on the network have responded. If all nodes are accounted for, then the process is complete at 267 (i.e., all nodes are identified and all repeaters have been assigned). If, however, certain nodes have not responded, then the master 100 selects additional first tier
5 repeater candidates in an effort to locate these nodes. Accordingly, the master 100 may select nodes which have signal strength values above the preset maximum 350.

Returning to the particular example illustrated in **Figure 3**, the master 100 may select any or all of nodes 101, 121-122, and 131 as new first tier candidates.
10 In one embodiment, the master selects nodes at a signal strength value in the vicinity of one half of the maximum threshold value 350, to increase the likelihood of identifying additional nodes.

At 275, the master 100 instructs the new first tier repeater candidates to collect proxy return signal strength data from any nodes which have not yet
15 responded. Thus, if node 131 is selected, it may attempt to collect signal strength data from nodes 132-134; and if node 121 is selected, it may attempt to collect signal strength data from node 125. The master continues to select new first tier candidates until new nodes have been identified (determined at 280).

Once new nodes respond, the process of searching through successive
20 tiers begins again at 230, where the master receives a new set of proxy return

signal strength data from the new first tier repeater candidate(s). The master then works its way through successive tiers as described above until no new nodes are responding (determined at 255). When all nodes have been identified (determined at 265) the process is complete (at 267).

5 In one embodiment, the master node 100 is not initially programmed with device addresses of each of the nodes. Rather, in this embodiment, the master node 100 transmits a broadcast search message, requesting a response from any nodes within its transmission range. As nodes respond to the broadcast search message, the master node 100 stores their device addresses and selects certain
10 nodes as repeaters as described above. Once selected by the master 100, the various repeater candidates may also send broadcast messages to any nodes within their transmission range.

 In one embodiment, once a node has responded to a broadcast search message, the master node 100 (or repeater candidate) instructs the node not to
15 respond to any subsequent broadcast search messages. Alternatively, or in addition, the master node 100 or repeater candidate may simply ignore subsequent responses to broadcast search message responses from nodes which have already responded.

 In one embodiment, an address of each intermediate node through which
20 a data packet will pass is included in an address field in the data packet. For

example, as illustrated in **Figure 4**, when the master 100 transmits a data packet 400 containing a particular command 410 (e.g., a proxy return signal strength command), it includes the addresses of each of the nodes, R1-R3, through which the packet will pass on its way to the destination node 405.

5 Similarly, in one embodiment, when the destination node 405 transmits data 420 (e.g., return signal strength or proxy return signal strength data) in response to the master's command 405, it includes an address of each intermediate node, R3-R1, through which the data packet will pass on its way to the master 100.

10 It should be noted, however, that various other routing techniques may be implemented while still complying with the underlying principles of the invention. For example, in one embodiment, each node may store a routing table in memory for routing data packets across the network. In this embodiment, only the destination node address (and not the intermediate addresses) is
15 incorporated in the data packet. Each node that receives the data packet in this embodiment checks its routing table to determine the next node to which the packet should be routed (i.e., what the next intermediate node is).

 Embodiments of the system and method described herein may be configured to operate differently depending on the overall size of the network.

20 For example, if the network is small enough so that probing all or most of the

nodes does not require an unreasonable amount of time, then the best candidates for repeaters can be identified quickly by using the method set forth in **Figures 2a-b**.

However, if the network is large (e.g., above some threshold number of nodes) so that probing most or all the nodes in a reasonable amount of time is not possible, then one embodiment of the system and method can be used to quickly identify repeating nodes so that communications can be established with all nodes. The time/resource advantage of this embodiment is realized because fewer of the communicating nodes need to be probed to identify repeaters for the remaining nodes. In a large network, after communication is established with all nodes, additional available resources can be used to identify better repeater or alternate repeater candidates.

In one embodiment of the system, repeaters do not separate the physical medium over which they communicate into separate "channels." Rather, in this particular embodiment, repeaters re-transmit data on the same channel on which they receive the data (hereinafter "disconnected channel"). However, it should be noted that the underlying principles of the invention are not limited to any particular type of communication channel.

Proxy Architecture

As illustrated in **Figures 5a** through **5c**, in one embodiment, nodes may be configured as proxy sources 500, proxy repeaters 510, proxy agents 520, and/or proxy targets 530. Generally speaking, a proxy source 500 communicates with a proxy target 520 through a proxy repeater 510 and/or a proxy agent 520. In one embodiment, node designations occur automatically, after the nodes have been physically connected to the network (e.g., as described above with respect to repeater selection).

A proxy source 500 is any node originating a proxy transaction. In one embodiment, the proxy source 500 generates a proxy operation by attaching a proxy header to a standard (i.e., non-proxy) data/command packet. One example of a standard data/command packet is a command requesting the value of a particular variable at a target node. If the target node is within transmission range of the source node (i.e., if no hops are required through intermediate nodes), then the source node simply transmits the packet directly to the target using the target's network address and waits for the response. If, however, the target node is outside of the source node's transmission range, then in one embodiment, the source attaches a proxy header to the packet, indicating one or more intermediate nodes (e.g., the proxy repeater 510 and the proxy agent 520) through which the data/command packet must pass to arrive at the target node (or in this case the "proxy" target node 530).

Any nodes which are electrically positioned between the proxy source 500 and proxy agent 520 may be configured as proxy repeaters 510. In one embodiment, when a proxy repeater 510 receives a data/command packet directed to the proxy target 530 it relays the message on to the next proxy repeater, or to the proxy agent 520 (if it is the last proxy repeater 510 in the chain).

A proxy agent 520 is any node which communicates directly with the proxy target 530. In one embodiment, the proxy agent 520 transmits a standard data/command packet to the proxy target 530, rather than a proxy packet (i.e., one with a "proxy" header).

Once the command has been received and processed at the proxy target 530, it generates a response packet addressed to the proxy agent 520 containing the data requested by the proxy source 500. The proxy agent 520 forwards the message to the proxy repeater 510 (by attaching the proxy repeater's address to the packet) which, in turn, forwards the message to the proxy source 500.

It should be noted that various packet addressing and routing techniques may be implemented between the various nodes illustrated in **Figures 5a-c** while still complying with the underlying principles of the invention. For example, in one embodiment, a packet transmitted by the proxy source 500 includes an address header with an address of each node through which the packet must

pass to arrive at the proxy target 530. Each node in the transmission path receives the packet, strips its own address from the header and forwards the packet on to the next node in the path (identified by the next address in the header). Each node remembers (i.e., stores in memory) the address of the node from which it received the packet.

After processing the packet (e.g., executing the command and collecting any requested data) the proxy target 530 transmits a response packet back to the proxy agent 520. In one embodiment, the response packet includes only the proxy agent's 520's address. The proxy agent 520, which previously stored the address of the proxy repeater 510 in memory, uses this address to forward the packet back to the proxy repeater 510; which, in turn, transmits the packet to the proxy source 500 using the address of the proxy source 500 which the proxy repeater 510 previously stored in memory.

In contrast to the foregoing addressing/routing scheme, in one embodiment, addresses are not stripped from data packets as they pass from one node to the next. Rather, in this embodiment, a packet is transmitted from the proxy source 500 through to the proxy target 530 with an address of each node in the transmission path embedded in the packet's header. In one embodiment, the packet's header also includes a counter/pointer value which points to the next address in the transmission path. Each node that receives the packet increments (or decrements, depending on the particular algorithm) the counter/pointer

value so that it points the next address in the packet's header. In one embodiment, when the proxy target 530 receives the packet, it resets the counter and transmits a response packet containing each node address (e.g., in reverse order).

5 It should be noted that various other addressing and/or routing techniques may be implemented while still complying with the underlying principles of the invention.

Transaction Control

Various transaction control mechanisms may be employed to provide
10 reliable message transmission between network nodes. For example, a node may retransmit a data/command packet if it does not receive a response for a predetermined period of time. Thus, as illustrated in **Figure 5b**, if a message (3) between the proxy agent 520 and proxy target 530 is blocked (e.g., due to interference on the network), the proxy agent 520 will retransmit the message (4)
15 if it does not receive a response from the proxy target 530 after a predefined period of time. As described below, in one embodiment, the retry timing (i.e., the timing for retransmitting a lost message) employed at each of the nodes is highly configurable and can be programmed based on a variety of network variables (e.g., the number of hops between the node and the proxy source 500
20 and/or proxy target 530).

service types may be employed while still complying with the underlying principles of the invention.

Note that when a response is lost on a disconnected channel, message collisions are avoided by virtue of the fact that all the nodes' retry timers are out
5 of sync by the packet propagation delay time between them.

Figure 5b illustrates an exemplary message sequence when a transmission error occurs between the proxy agent 520 and the proxy target 530. More particularly, message 3 is lost on its way from the proxy agent 520 to the proxy target 530. The proxy agent 520, after not receiving a response from the proxy
10 target 530 for a predefined retry time period, retransmits the message (message 4) and receives a response (message 5). The proxy repeater 510 in this embodiment does not retransmit message 2 while waiting for message 6 because its retry timer is set to a longer period than the proxy agent's 520's.

Figure 5c illustrates an exemplary message sequence in when an
15 intermediate response (message 5) transmitted from the proxy agent 520 to the proxy repeater 510 is lost. The proxy repeater 510 transmits message 2 (e.g., a request/response message) to the proxy agent 520 and, after waiting for a response for the retry time period, retransmits the message (illustrated as message 7). The proxy agent 520 then retransmits the response message
20 (message 8) to the proxy repeater 510.

As described in greater detail below, nodes may be programmed to store messages and message responses in memory. Thus, in Figure 5c, when the proxy repeater 510 retransmits its message (message 7), the proxy agent 520 can immediately retransmit the response (message 8) which it previously stored in memory.

It should be noted that, in the foregoing example, message 6 is superfluous, but harmless (i.e., the proxy repeater 510 may be configured to ignore it). In one embodiment, the proxy source's 500's retry timer may be set long enough to prevent this re-transmission. However, exponentially increasing retry timers in this manner may become problematic in certain situations (e.g., with a large number of repeaters).

Response Flow

For request/response transactions carried out under one embodiment, although the response packet relayed upstream will be identical to that originally sent by the proxy target 530, the source address of the response received by the proxy source 500 from the first repeater 510 will be that of the repeater, not the proxy target 530.

In one embodiment, each proxy repeater/agent buffers any responses it receives. This way, if a response is lost in transmission (e.g., message 5 of Figure

5c), and a request retry is received, it will not be necessary to re-fetch the response from the downstream path.

In one embodiment, this buffering feature is accomplished at a proxy layer configured in the network protocol stack. As illustrated in **Figure 6**, in one
5 embodiment, the proxy layer 620 resides between a transaction/authentication layer 630 and a network variables layer 610. As indicated, these layers roughly correspond to the transport/session layers (L4-5) and the presentation layer (L6) of the Open System Interconnection ("OSI") model.

In one embodiment, an agent/target transaction may be a different type of
10 transaction from the corresponding repeater/agent transaction. For example, the repeater/agent transaction may be a request/response message whereas the agent/target transaction may be a acknowledged message multicast to a group of nodes. In this embodiment, the response transmitted from the agent to the repeater may be a simple one-byte completion code conveying success or failure
15 of the underlying transaction. For example, the agent could send an acknowledged multicast to a group and upon receiving all the acknowledgements, send a "success" response upstream. Similarly, if the agent/target transaction is request/response and no response is received, a "failure" response may be sent upstream along with the repeater index of the
20 node detecting the failure.

Priority

In an embodiment in which contention-based channels are used, message priorities may be defined. For example, a proxy source 500 may define a priority level (e.g., priority = 1, 2, 3, . . . etc) for each message it generates. In one
5 embodiment, priority may be strictly inherited. For example, if a proxy source 500 defines a priority, then priority is used by all proxy repeaters 510 and the proxy agent 520.

Authentication

Various authentication techniques may be implemented to provide for
10 secure message transmission across the network. In one embodiment, authentication, like priority, may be inherited. In this embodiment, each hop may be authenticated separately. For example, the first proxy repeater may challenge the proxy source and receive a successful reply before relaying the proxied message on to the next proxy repeater or proxy agent.

15 In one embodiment, in order to support changing of authentication keys, an authentication key may be embedded in a proxy message header for the proxy agent 520 to use when communicating with the proxy target 530. This configuration handles the case where the agent and target have different authentication keys (presumably only temporarily). In one embodiment, the
20 proxy source 500 ensures that authentication keys are the same in the intermediate points of the proxy chain (e.g., the proxy repeaters 510) before

using authentication. The proxy agent 520 of one embodiment is capable of using the authentication key only for that outgoing transaction rather than changing its own key.

The authentication key passed down for such messages may be in the form of a key increment. In other words, the proxy agent 520 will use its own key and add the key increment to it to derive the proxy target's 530's key. This feature will provide secure authentication without the need for transmitting the authentication key over a non-secure channel.

Multicast

In one embodiment, unacknowledged broadcast and group messages are handled in a special way. In this case, each proxy repeater may serve as both a proxy agent and a proxy repeater. When a proxy repeater identifies an unacknowledged broadcast or group message as the message to be delivered by the proxy agent (by peeking ahead to the end of the proxy header), it first sends the message as if it were a proxy agent and then relays the message on to the next proxy repeater or proxy agent.

Note that any given node may receive such a multicast more than one time. Therefore, in one embodiment, it is necessary that such multicasts be idempotent.

Addressing

In one embodiment, a single domain scheme is used. Thus, the proxy repeaters 510 and proxy agent 520 of this embodiment may use the same domain ID as the proxy source 500. Accordingly, proxy repeaters 510 and proxy agents
5 520 may be commissioned with a domain ID topologically, closest to the proxy source 500 first.

In one embodiment, the proxy source 500 uses unicast (e.g., subnet/node) addressing to communicate with the first proxy repeater 520 (although other addressing modes may be used as well). The proxy header used in this
10 embodiment may contain only unicast addresses so all repeater-to-repeater and repeater-to-agent downstream messages are unicast.

Alternate Path

Some types of media provide multiple paths over which to transmit. For example, multiple frequency bands might be used for transmission, some more
15 likely to function than others depending on types of interference. In one embodiment, the channel provides two paths, a primary and alternate path, and the path to be used at each hop is encoded on a per-hop basis in the proxy header.

Routing Tables

The proxy source may be supplied with a routing table containing for each unicast address (subnet/node or node ID), a list of repeaters and the agent to use to reach that address (e.g., perhaps a null set), as well as a first choice path to use at each hop. For multicast addresses, the list may contain the set of agents to which the multicast is to be delivered.

Embodiments of the invention include various steps, which have been described above. The steps may be embodied in machine-executable instructions. The instructions can be used to cause a general-purpose or special-purpose processor to perform certain steps. Alternatively, these steps may be performed by specific hardware components that contain hardwired logic for performing the steps, or by any combination of programmed computer components and custom hardware components.

Embodiments of the invention may also be provided as a machine-readable medium for storing the machine-executable instructions. The machine-readable medium may include, but is not limited to, floppy diskettes, optical disks, CD-ROMs, and magneto-optical disks, ROMs, RAMs, EPROMs, EEPROMs, magnet or optical cards, propagation media or other type of media/machine-readable medium suitable for storing electronic instructions. For example, the present invention may be downloaded as a computer program which may be transferred from a remote computer (e.g., a server) to a requesting

computer (e.g., a client) by way of data signals embodied in a carrier wave or other propagation medium via a communication link (e.g., a modem or network connection).

Throughout the foregoing description, for the purpose of explanation,
5 numerous specific details were set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention may be practiced without some of these specific details.

For example, while **Figure 1** illustrates a terrestrial network configuration, various non-terrestrial configurations such as radio frequency broadcast, satellite
10 broadcast, personal communication services ("PCS"), Global System for Mobile Communications ("GSM"), and cellular (including code division multiple access ("CDMA") and time division multiple access ("TDMA")) may be implemented while still complying with the underlying principles of the invention. Moreover, one embodiment of the invention employs a heterogeneous network
15 configuration, including both terrestrial and non-terrestrial components.

Similarly, although the proxy layer is illustrated in **Figure 6** between the transaction/authentication layer 630 and the network variables layer 610, alternate embodiments may incorporate the same proxy functionality at other layers in the OSI model. For example, in one embodiment, the network functions
20 described above are implemented at the network/addressing layer (i.e., OSI

CLAIMS

What is claimed is:

- 1 1. A system comprising:
2 a source node configured to transmit a data packet to a target node across
3 a data network, said source node having a first retry timer set to a first retry time
4 period after which said source node will retransmit a data packet if it has not
5 received an appropriate response to said data packet; and
6 a first intermediate node electrically positioned between said source node
7 and said target node, said first intermediate node having a second retry timer set
8 to a second retry time period after which said first intermediate node will
9 retransmit said data packet if it has not received an appropriate response to said
10 data packet,
11 wherein said first retry time period is longer than said second retry time
12 period.
- 1 2. The system as in claim 1 further comprising:
2 a second intermediate node electrically positioned between first
3 intermediate node and said target node, said second intermediate node having a
4 third retry timer set to a third retry time period after which said second
5 intermediate node will retransmit said data packet if it has not received an
6 appropriate response to said data packet,
7 wherein said third retry time period is shorter than said second retry time
8 period.
- 1 3. The system of claim 2 wherein said first, second and third retry timers
2 are set by said data packet transmitted from said source node.

1 4. The system of claim 1 wherein said source node is configured to
2 retransmit said data packet a first predetermined number of times if it has not
3 received an appropriate response to said data packet.

1 5. The system of claim 4 wherein said intermediate node is configured to
2 retransmit said data packet a second predetermined number of times if it has not
3 received an appropriate response to said data packet.

1 6. The system of claim 5 wherein said first predetermined number of
2 times is greater than said second predetermined number of times.

1 7. The system of claim 2 wherein said second intermediate node is a
2 proxy agent and said first intermediate node is a proxy repeater.

1 8. A system for providing proxy communication for a standard set of
2 network commands comprising:
3 a source node attaching a proxy header to a packet in which one of said
4 standard network commands is encapsulated, said proxy header identifying an
5 agent node,
6 said agent node, upon receipt of said packet with said proxy header,
7 communicating with a target node using said standard network command.

1 9. The system as in claim 8 further comprising:
2 a first repeater node electrically positioned between said agent node and
3 said source node, said first repeater node to forward said packet with said proxy
4 header to said agent node.

1 11. The system as in claim 9 further comprising:
2 a second repeater node electrically positioned between said source node
3 and said first repeater node, said second repeater node configured to forward
4 said packet to said first repeater node.

1 12. The system as in claim 11 wherein said second repeater node is
2 configured to remove its address from said proxy header before forwarding said
3 packet on to said first repeater node.

1 13. The system as in claim 9 wherein said first repeater is further
2 configured to store address data for a return path to said source node, said
3 address data used for forwarding said target node's response to said packet.

1 14. The system as in claim 11 wherein said second repeater is further
2 configured to store address data for a return path to said source node, said
3 address data used for forwarding said target node's response to said packet.

1 15. The system as in claim 8 wherein said standard network command is
2 a request/response command.

1 16. A method for providing transaction control between a source node
2 and a target node, said source node and said target node communicating across
3 one or more repeater nodes, the method comprising:

1 20. The system of claim 16 wherein said first repeater node is configured
2 to retransmit said data packet to said target node a second predetermined
3 number of times if it has not received an appropriate response to said data
4 packet.

1 21. The system of claim 20 wherein said first predetermined number of
2 times is greater than said second predetermined number of times.

1 22. The system of claim 17 wherein said second repeater node is a proxy
2 agent and said first repeater node is a proxy repeater.

1

09:39:08.100 09:39:08.100

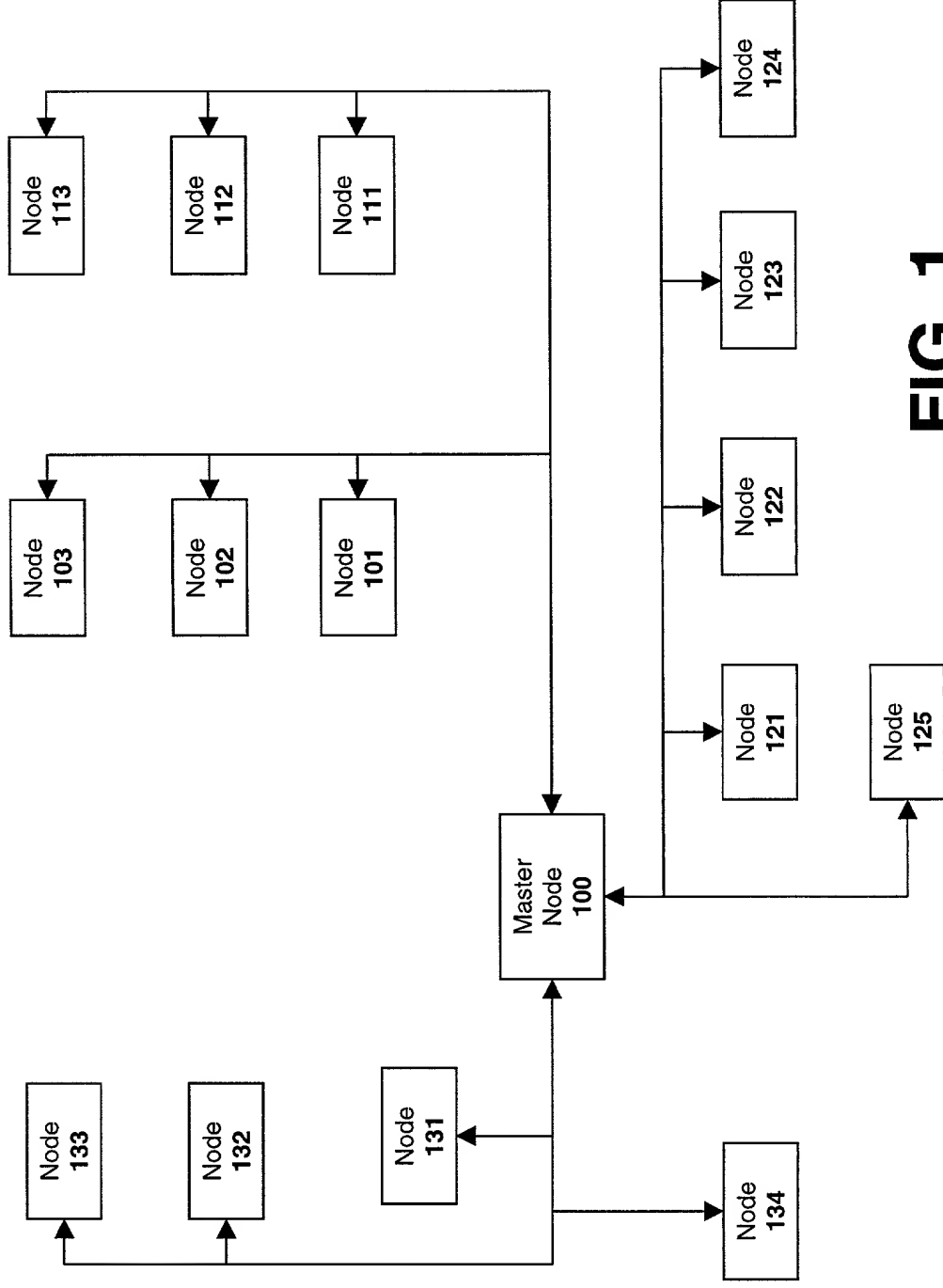


FIG. 1

```

graph TD
    A((A)) --> 210[Master attempts to communicate with all nodes  
210]
    210 --> 215[Master receives signal strength data from a subset of all nodes  
215]
    215 --> 220[Master performs signal strength analysis to identify first tier of repeater candidates  
220]
    220 --> 225[Master instructs first tier of repeater candidates to collect proxy signal strength data for nodes that have not responded  
225]
    225 --> 230[Master receives proxy signal strength data from first tier of repeater candidates  
230]
    230 --> 235[N=2  
235]
    235 --> 240[Master performs proxy signal strength analysis to identify tier N of repeater candidates  
240]
    240 --> 245[Master instructs tier N of repeater candidates to collect proxy signal strength data for nodes that have not responded  
245]
    245 --> 250[Master receives proxy signal strength data from tier N of repeater candidates  
250]
    250 --> 255{New nodes responded?  
255}
    255 -- No --> B((B))
    255 -- Yes --> 257[N=N+1  
257]
    257 --> 240

```

FIG. 2a

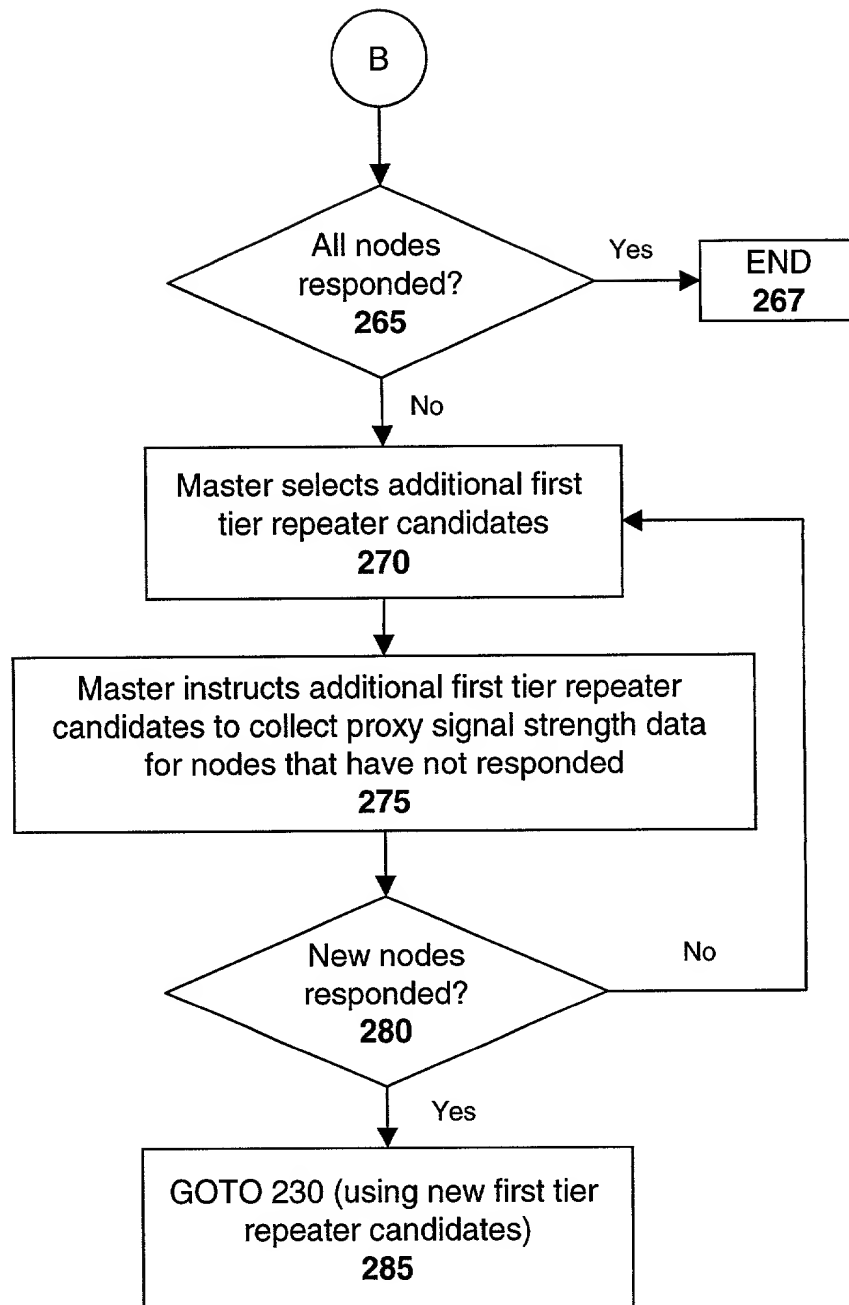


FIG. 2b

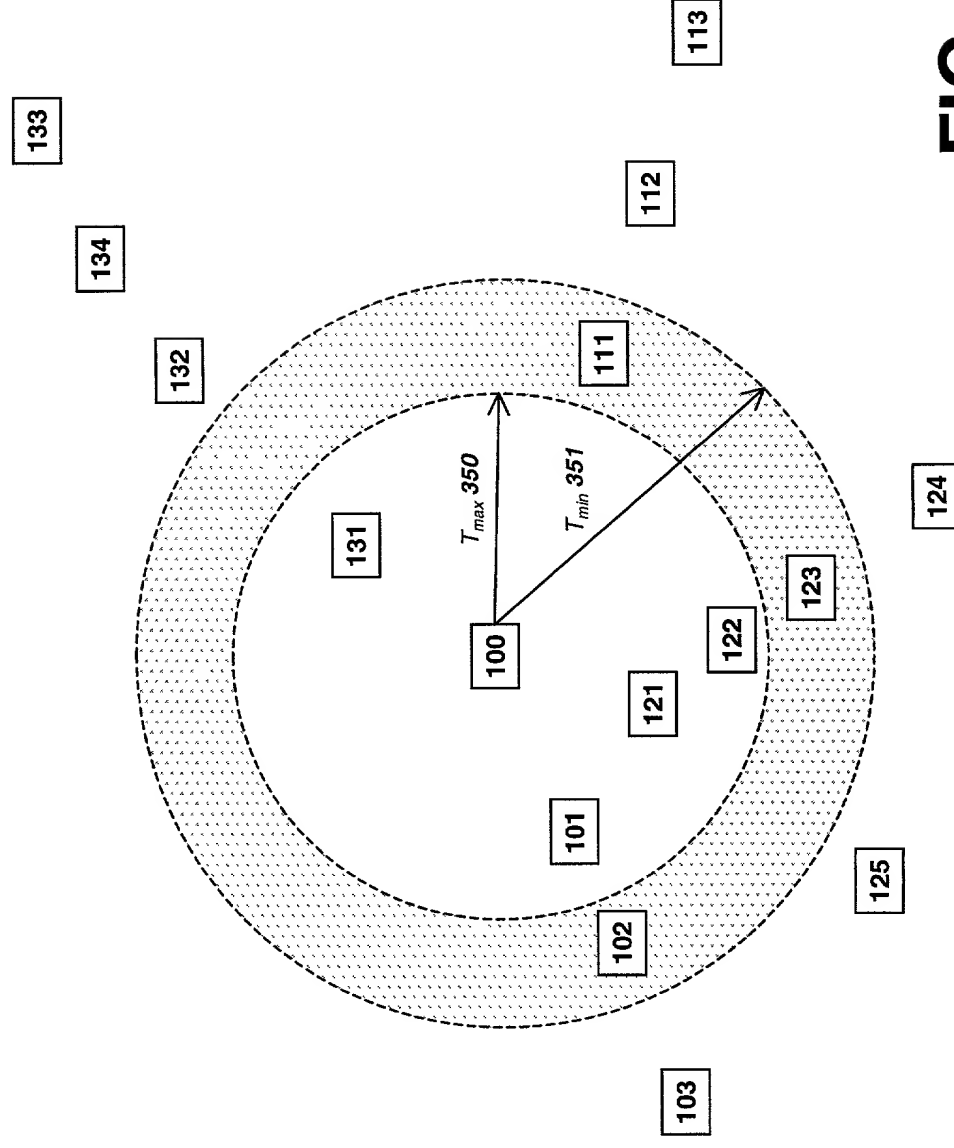


FIG. 3

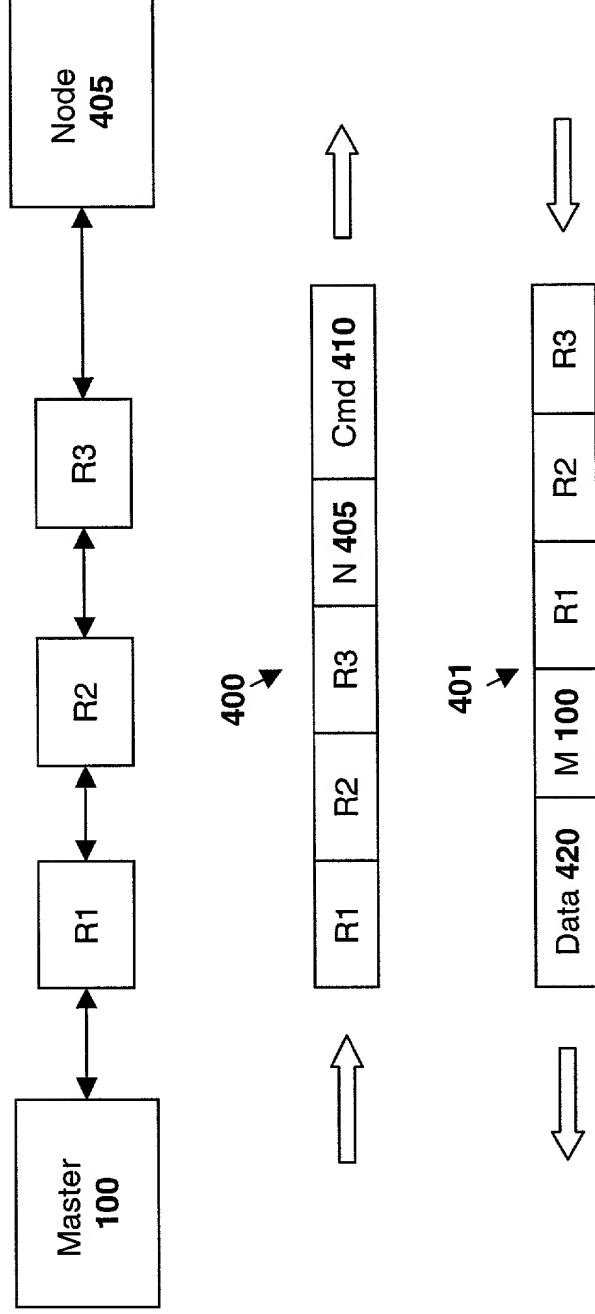


FIG. 4

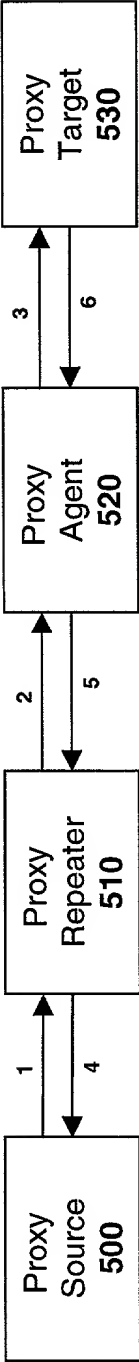


FIG. 5a

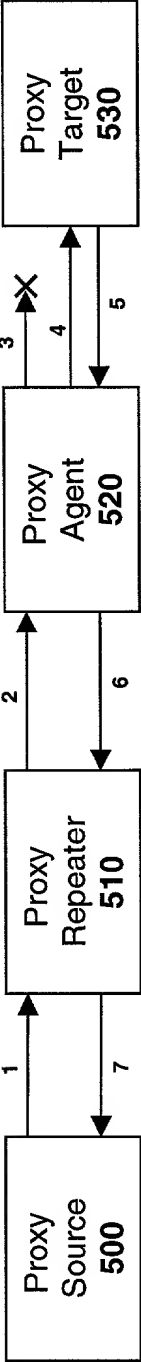


FIG. 5b

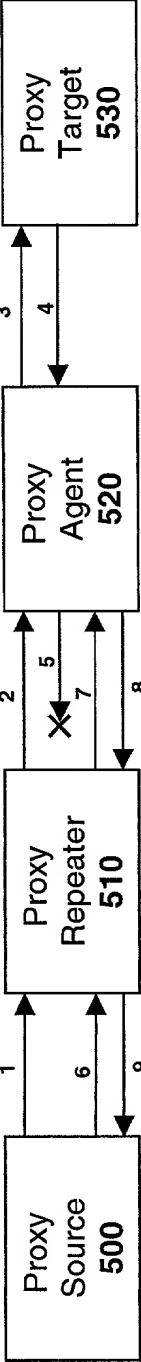


FIG. 5c

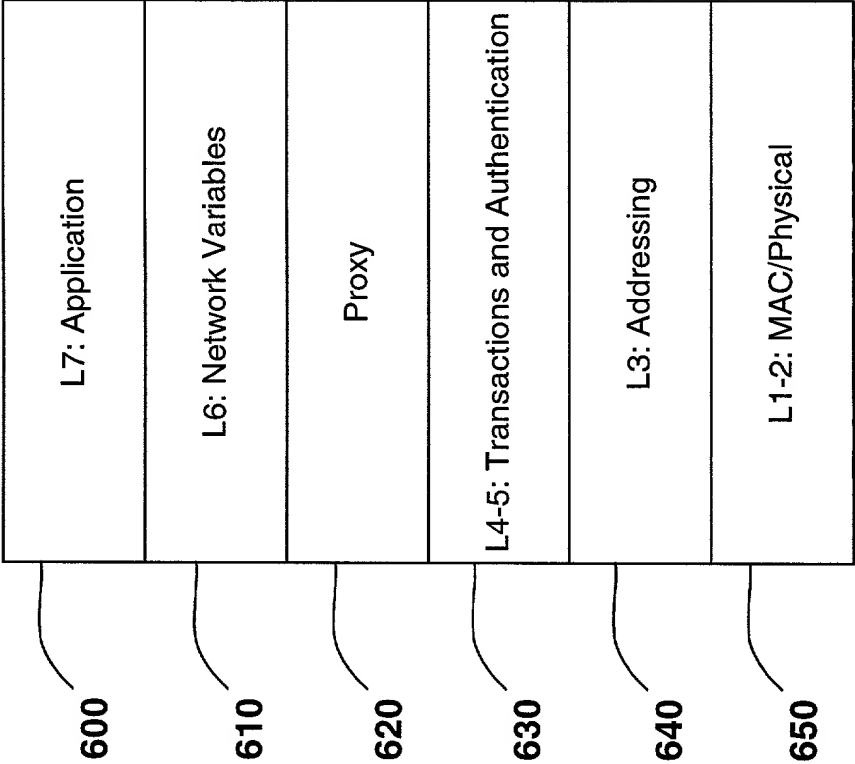


FIG. 6

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A System And Method For Providing Transaction Control On A Data Network

the specification of which

 X is attached hereto.
 was filed on _____ as
United States Application Number _____
or PCT International Application Number _____
and was amended on _____.
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority
Claimed

| | | | | |
|-------------------|--------------------|---------------------------------|--------------|-------------|
| _____ (Number) | _____ (Country) | _____ (Day/Month/Year Filed) | _____ Yes | _____ No |
| _____ (Number) | _____ (Country) | _____ (Day/Month/Year Filed) | _____ Yes | _____ No |
| _____ (Number) | _____ (Country) | _____ (Day/Month/Year Filed) | _____ Yes | _____ No |

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

| | |
|-------------------------------|----------------------|
| _____ (Application Number) | _____ Filing Date |
| _____ (Application Number) | _____ Filing Date |

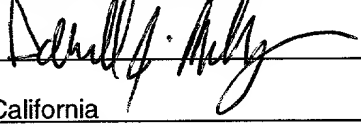
I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

| | | |
|-------------------------------|----------------------|--|
| _____ (Application Number) | _____ Filing Date | _____ (Status -- patented, pending, abandoned) |
| _____ (Application Number) | _____ Filing Date | _____ (Status -- patented, pending, abandoned) |

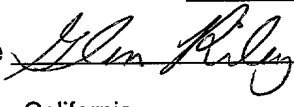
I hereby appoint the persons listed on Appendix A hereto (which is incorporated by reference and a part of this document) as my respective patent attorneys and patent agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Thomas C. Webster, BLAKELY, SOKOLOFF, TAYLOR &
(Name of Attorney or Agent)
ZAFMAN LLP, 12400 Wilshire Boulevard 7th Floor, Los Angeles, California 90025 and direct
telephone calls to Thomas C. Webster, (408) 720-8300.
(Name of Attorney or Agent)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor Darrell Duffy
Inventor's Signature  Date 8/3/00
Residence Sunnyvale, California Citizenship USA
(City, State) (Country)

Post Office Address 1390 Flicker Way
Sunnyvale, CA 94087-3407

Full Name of Second/Joint Inventor Glen Riley
Inventor's Signature  Date 8/3/00
Residence Saratoga, California Citizenship USA
(City, State) (Country)

Post Office Address 20035 Charters Court
Saratoga, CA 95070

Full Name of Third/Joint Inventor _____
Inventor's Signature _____ Date _____
Residence _____ Citizenship _____
(City, State) (Country)

Post Office Address _____

Full Name of Fourth/Joint Inventor _____
Inventor's Signature _____ Date _____
Residence _____ Citizenship _____
(City, State) (Country)

Post Office Address _____

APPENDIX A

William E. Alford, Reg. No. 37,764; Farzad E. Amini, Reg. No. P42,261; Aloysius T. C. AuYeung, Reg. No. 35,432; William Thomas Babbitt, Reg. No. 39,591; Carol F. Barry, Reg. No. 41,600; Jordan Michael Becker, Reg. No. 39,602; Bradley J. Berezna, Reg. No. 33,474; Michael A. Bernadieu, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; Gregory D. Caldwell, Reg. No. 39,926; Ronald C. Card, Reg. No. 44,587; Andrew C. Chen, Reg. No. 43,544; Thomas M. Coester, Reg. No. 39,637; Alin Corie, Reg. No. P46,244; Dennis M. deGuzman, Reg. No. 41,702; Stephen M. De Klerk, under 37 C.F.R. § 10.9(b); Michael Anthony DeSanctis, Reg. No. 39,957; Daniel M. De Vos, Reg. No. 37,813; Robert Andrew Diehl, Reg. No. 40,992; Sanjeet Dutta, Reg. No. P46,145; Matthew C. Fagan, Reg. No. 37,542; Tarek N. Fahmi, Reg. No. 41,402; Paramita Ghosh, Reg. No. 42,806; James Y. Go, Reg. No. 40,621; James A. Henry, Reg. No. 41,064; Willmore F. Holbrow III, Reg. No. P41,845; Sheryl Sue Holloway, Reg. No. 37,850; George W. Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; William W. Kidd, Reg. No. 31,772; Sang Hui Kim, Reg. No. 40,450; Eric T. King, Reg. No. 44,188; Erica W. Kuo, Reg. No. 42,775; Kurt P. Leyendecker, Reg. No. 42,799; Michael J. Mallie, Reg. No. 36,591; Andre L. Marais, under 37 C.F.R. § 10.9(b); Paul A. Mendonsa, Reg. No. 42,879; Darren J. Milliken, Reg. No. 42,004; Lisa A. Norris, Reg. No. 44,976; Chun M. Ng, Reg. No. 36,878; Thien T. Nguyen, Reg. No. 43,835; Thinh V. Nguyen, Reg. No. 42,034; Dennis A. Nicholls, Reg. No. 42,036; Daniel E. Ovanezian, Reg. No. 41,236; Marina Portnova, Reg. No. P45,750; Babak Redjaian, Reg. No. 42,096; William F. Ryann, Reg. No. 44,313; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195; Jeffrey Sam Smith, Reg. No. 39,377; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Judith A. Szepesi, Reg. No. 39,393; Vincent P. Tassinari, Reg. No. 42,179; Edwin H. Taylor, Reg. No. 25,129; John F. Travis, Reg. No. 43,203; George G. C. Tseng, Reg. No. 41,355; Joseph A. Twarowski, Reg. No. 42,191; Lester J. Vincent, Reg. No. 31,460; Glenn E. Von Tersch, Reg. No. 41,364; John Patrick Ward, Reg. No. 40,216; Mark L. Watson, Reg. No. P46,322; Thomas C. Webster, Reg. No. P46,154; Charles T. J. Weigell, Reg. No. 43,398; Kirk D. Williams, Reg. No. 42,229; James M. Wu, Reg. No. 45,241; Steven D. Yates, Reg. No. 42,242; and Norman Zafman, Reg. No. 26,250; my patent attorneys, and Justin M. Dillon, Reg. No. 42,486; my patent agent, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, and James R. Thein, Reg. No. 31,710, my patent attorney.

APPENDIX B

Title 37, Code of Federal Regulations, Section 1.56 Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

- (1) Prior art cited in search reports of a foreign patent office in a counterpart application, and
- (2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made or record in the application, and

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or
- (2) It refutes, or is inconsistent with, a position the applicant takes in:
 - (i) Opposing an argument of unpatentability relied on by the Office, or
 - (ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

- (1) Each inventor named in the application;
- (2) Each attorney or agent who prepares or prosecutes the application; and
- (3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.